REMARKS

The following remarks are submitted in response to the Office Action dated July 16, 2003 regarding the above-identified U.S. Patent Application.

Claims 21-46 are currently pending in this application, claims 1-20 having been canceled. Claims 21-23, 32-34 and 38-45 have been rejected under 35 U.S.C. § 102(b) as anticipated by Forster et al. (U.S. Patent No. 4,627,269), while claims 24-31, 35-37 and 46 have been rejected under 35 U.S.C. § 103(a) as unpatentable over Forster et al. in view of Ruhland et al. ("Gas-kinetic Interactions of Nitrous Oxides with Sno_2 Surfaces"). However, for the reasons set forth hereinafter, applicants respectfully submit that claims 21-46 distinguish over both of the cited references, whether considered separately or in combination.

The present invention is directed to a gas analysis method and apparatus of the type in which the gas in question is brought into contact with a gas sensitive layer which has been heated to a measuring temperature. By measuring the electrical resistance of the gas sensitive layer at a specific temperature, gas concentrations, for example of CO, NOx or O3 can be determined. However, when the gas in question comprises several components, the problem arises that the effects of the individual gas components may be superimposed in such a manner as to corrupt the measurement signal. For example, at a measuring temperature of 400° C, the bombardment of a gas sensitive layer with CO or NO leads to a reduction in the electrical resistance of the gas sensitive layer, while bombardment with NO_2 at this temperature results in an increase in electrical resistance. Thus,

the concentrations of the individual gases in the gas mixture frequently cannot be determined with precisions.

The present invention provides a gas analysis method and apparatus which addresses and resolves this problem in a manner which is simple and cost effective by enclosing the gas sensitive layer in a sealed chamber, whose volume is small enough that at least one component of the gas or gas mixture is largely exhausted by conversion within a predetermined measuring interval. This technique utilizes the fact that after an individual component of the gas has been converted during the measuring process, it no longer contributes significantly to the measuring signal. The remaining measuring signal therefore no longer contains the superimposed effects of the respective gas components that have been converted, allowing the concentrations of the remaining components to be determined more easily.

The latter features of the invention are included in claim 21, which recites in the penultimate paragraph that "during measurement a limited supply of individual gases in the chamber is at least partially converted", and in the paragraph, it further recites that the volume of the chamber "is such so that at least one component of a limited gas store within the chamber is substantially exhausted via conversion within a predetermined measuring interval." These features of the invention are neither taught or suggested by either of the cited references.

The Office Action states at paragraph 1, page 2 that the gas sensor according to claim 21 is provided by the sensors shown in Figures 1 and 11 or Forster et al. However, the Forster et al. measuring method and apparatus are based on the

proposition that the gas mixture to be investigated is periodically exchanged against a reference gas having a smaller content of a reducing gas. Thus, the gas detector of Forster et al. comprises a reference chamber which is closed, and a measuring chamber which is in flow communication with the reference chamber, as discussed at column 4, lines 30-52. In Figure 1 of Forster et al., the measurement chamber 7 is provided with valves 161, 162 and 164. During the measurement phase the gas mixture to be investigated and present in the measuring chamber 7 is periodically replaced by a reference gas mixture, and blown off through the vent opening 91. For this purpose, a gas displacement ring 4 periodically flexes towards the left and right side in Figure 1 in order to exchange the gas to be measured with the reference gas mixture. (See Figure 1 and column 10, line 45 through column 11, line 30.) During the measurement process, which is illustrated in Figures 3 and 4, the gas mixture in the measuring chamber is sucked into the chamber and blown out of the chamber numerous times (Figures 3c and 4c), with the temperature of the sensitive layer being changed during at least one heating cycle (Figure 3b and 4b).

Therefore the Forster et al. apparatus fails to teach or show a valve arrangement provided to seal the chamber from the outside and keep it closed during the measurement process. Rather, the valve arrangement according to Forster et al. is provided in order to periodically open and close the chamber, to exchange the gas in the chamber and to blow it out during the measurement process.

The same observations apply with regard to the apparatus illustrated in Figure 11 of Forster et al. as well. There, the measuring chamber 7 is connected by an aperture 8 to the reference chamber 5 having a volume 1000 times larger than that of the measuring chamber 7. During the measurement process, the gas to be investigated is drawn through the inlet opening 9, through the measuring chamber 7 passing gas sensor 11 into the reference chamber 5. During the suction phase, the gas mixture to be investigated is at least partially freed from reducing gases. During the following venting phase of the measurement process, the mix gases forced back from the reference chamber 5 through the measuring chamber 7, and leaving the measuring chamber 7 through the inlet opening 9. (See column 18, line 31 through column 19, line 22; see also Figure 11.) Thus, during measurement, there is no limited supply of individual gas in the chamber which is at least partially converted.

Further, the volume of the measuring chamber is not such that a component of a limited gas store within the chamber is substantially converted within a predetermined measuring interval, as recited in claim 21. Instead, during the measurement process, gas is supplied to the outside through the inlet opening 9 and pumped through the measuring chamber 7 in a first measuring phase, and pumped back through the outside during a second measuring phase.

It is significant in the latter regard to note that nothing in Forster et al. teaches or suggest that the chamber 7 is provided with a volume such that "at least one component of a limited gas store within the chamber is substantially exhausted

via conversion within a predetermined measuring interval." In particular, the volume of the measuring chamber 7 in Forster et al. is such that the chamber is periodically filled by either the gas mixture or the reference gas, as completely as possible. The volume of the measuring chamber 7 is matched to the volume of the gas sensor 11, such that the latter fills the measuring chamber as completely as possible, as indicated at column 11, line 62 through column 12, line 15. The Forster et al. reference contains no discussion of choosing the volume of the chamber such that at least a component of a limited gas store within the chamber is substantially converted within a predetermined measuring interval. Rather, on the contrary, gas coming from the outside and pumped through the measuring chamber is at least partially converted during a suction phase. (See column 19, lines 10-14.)

As can be seen from the foregoing brief discussion, neither the valve arrangement nor the measuring chamber in Forster et al. corresponds to or suggest the features of the present application.

The same comments also apply to the method of gas analysis recited in claim 38. In particular, the method shown in Forster et al. (Figures 3 and 4) does not show that the measuring chamber is sealed during the measurement process, and does not show that the measuring signal is examined when at least one component of the gas has been exhausted, by a conversion within the chamber, to a point at which it no longer supplies any significant contribution to the measuring signal. Rather, according to Forster et al., the chamber is open in order to exchange the gas periodically with the reference gas, and the measuring signal is examined by

comparing the gas passing through the chamber with that associate with a reference gas provided in the reference chamber. Further, the gas sensitive layer according to Forster et al. is not held at a predetermined measuring temperature. Instead, its temperature is varied in one or more heating cycle operations, as can be seen in Figures 3b and 4b.

The Ruhland et al. article, on the other hand, is cited as disclosing a heater made of a platinum heating resistor arranged in a meandering pattern; a passivating layer made of SiO_2 position between the heater and the gas sensitive layer; contact electrodes made of platinum; a silicon substrate as a carrier and a nitride membrane which separates the heater from the carrier; a gas sensitive layer made of SnO_2; and measuring concentrations of CO, NO_2 and NO in a chamber made of silicon. Like Forster et al., however, the Ruhland et al. article contains no teaching or discussion which suggests the combination defined in claim 21 or the method defined in claim 38, in which against gas sensing layer is provided in a sealed chamber in which a limited supply of individual gases is at least partially converted, with the volume of the chamber being such that at least one component of the limited gas store within the chamber is substantially exhausted within a predetermined measuring interval. Accordingly, Ruhland et al. does not suggest a modification of the Forster et al. reference to achieve the invention recited in claims 21 and 38.

If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #056226.50547US).

Respectfully submitted,

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